



DETERMINATION OF CAFFEINE CONTENT IN SOME COMMONLY CONSUMED TEA BRANDS IN TARABA STATE

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Abstract

Caffeine is one of the most commonly use substance found in green seed coffee, green tea (*Camellia sinensis*) and other tea brand. Caffeine-containing products have been consumed for hundreds of years for their pleasant flavor and stimulating effects. The aim of this study is to determine the concentration of caffeine in some commonly consumed tea in Taraba state. Each tea sample was introduced into a 250ml beaker containing water and was boiled with the addition of Calcium trioxocarbonate to evaporate tannins. The solution was allowed to cool after filtration after which liquid to liquid extraction was done. Two layers of the solution was formed when tetra chloromethane was introduced into the solution. The caffeine moves into the tetrachloride phase since it is more soluble in carbon tetrachloride than water. Caffeine concentration present in SAM tea, Hilltop tea, Lipton tea, Top tea and Highland tea were calculated and showed values of 0.29, 0.17, 0.34, 1.05 and 0.34 in mg/ml. Top tea has the highest caffeine content, followed by Highland tea and Lipton tea. The least is hill top tea. The concentration of caffeine in top tea is the highest as a result, it would be the highest central nervous system stimulant among the other sample tested. This implies it could have a damaging effects among consumers, therefore, consumers' consumption of the beverage is to be minimized. Caffeine sometimes can cause negative health effect in some individuals, therefore quantities of caffeine need to be shown on the label for the interest of those consuming them.

Keywords: Caffeine, Coffee, Tea, Stimulant, beverages.

Introduction

Caffeine is a bitter white crystalline substance, a chemical compound with the molecular formula $C_8H_{10}N_4O_2$ is classified as alkaloid, belonging to the xanthine group and it is chemically designated as 1,3,7-trimethylxanthine (Cicero *et*

al.,2018). Caffeine is one of the most commonly use substance found in green seed coffee, green tea (*Camellia sinensis*) and other tea brand. Caffeine-containing products have been consumed for hundreds of years for their pleasant flavor and stimulating effects (Komes *et al.*,2009). This compound is found in certain plants, besides being consumed as stimulant in its infusion form in beverages (Cicero *et al.*,2018). The stimulating effects of coffee is due to the presence of caffeine which makes it one of the most popular beverages in the world. Apart from its stimulating effects, religious individuals used it to stay awake in all night prayers (Olumide and Oyedele, 2021). There are over eighty species of coffee that have been identified worldwide. Studies also showed that these coffee species also contain different level of caffeine concentration (Mulu *et al.*, 2018). Coffee and tea are among the most popular beverages worldwide and contain substantial amounts of caffeine, making caffeine the most widely consumed psychoactive agent. Caffeine is widely distributed in different parts of plant like roots, leaves, stems, seeds and the fruits (Rob *et al.*,2020). Tea beverage is also an important way to the intake of caffeine for modern people. Caffeine is the natural component of the tea itself, and is the main component of the tea taste. Caffeine content is an important indicator of tea beverage quality. Caffeine can also be synthesized and is added to foods and beverages, including soft drinks, energy drinks, energy shots and tablets marketed for reducing fatigue (Rob *et al.*,2020). The world's primary source of caffeine is the coffee "bean", from which coffee is brewed. Caffeine content in coffee varies widely depending on the type of coffee bean and the method of preparation used. Beans within a given plantation can show variations in concentration (Wanyika *et al.*,2010).

Caffeine

Caffeine is a member of a naturally occurring class of substance called Methyl xanthine white and crystalline in nature. It crosses the blood-brain barrier because of its hydrophobic nature (Andrew, 2005). Caffeine is the natural component of the tea itself, and is the main component of the tea taste. It is also the important quality indicator of the tea beverage (Jianbin and yipping, 2019). Caffeine was discovered in early 1827. It was originally called 'theine'. It was then found that caffeine of coffee and 'theine' of tea were almost identical and later caffeine completely replaced the term theine. Technically, caffeine in tea and coffee are alike. Its primary discovery dates back to the time of reign of Emperor Shennong of China when he accidentally discovered a fragrant and re-energizing drink when certain leaves fell into boiling water. Another person traces its discovery to Ethiopia where

a goat herder observed goats that became restless at nights after consuming coffee plants and he consumed the same to result in the same effects within him (Sriram, 2019).

Caffeine is naturally present in several foods, being one of the most consumed dietary ingredients in the world, however, excessive intake may cause health concerns. Caffeine can affect the tea quality characteristics, such as taste, contributing to the acidity and conferring astringency and bitterness. Several studies have reported the ability of caffeine to improve mood, attention, performance, alertness, speed at which information is processed and reaction time. On addition, a higher caffeine intake was associated with lower Parkinson's disease risk (Tfouni *et al.*, 2017). Caffeine has been recognized as a pollutant to environmental water worldwide, which may be due to its high consumption rate (Edwards *et al.*, 2015). In recent years, caffeine received increasing attention in food and pharmaceutical industries, due to its pharmacological properties which comprise stimulation of the central nervous system, peripheral vasoconstriction, relaxation of the smooth muscle, myocardial stimulation and also increases the activity of brain through its adenosine antagonist action (Komes *et al.*, 2009). Caffeine solubility is very low in water, slight in ethyl acetate, acetone, and very high in petroleum ether, benzene and chloroform (Kerebih *et al.*, 2020). Caffeine is used both recreationally and medically to reduce bodily fatigue and to restore alertness. Due to its pleasant taste, aroma and stimulant effect, and the presence of caffeine, coffee is the most popular and widely consumed beverage throughout the world (Kerebih *et al.*, 2020). It is white, crystalline solid in the form of needles. Its melting point is 238 o C. It is the main active principle component of tea leaves (Parvathy *et al.*, 2014). Caffeine containing beverages such as coffee beans, black tea leaves and Coca-Cola are the habitual beverages, especially in the Mambilla plateau where the weather most time is cool and other parts of the country in in the winter. But most coffee drinkers taking overdose have been exposed to bring about a circumstance of central Nervous System overstimulation known as caffeine intoxication (Kerebih *et al.*, 2020). It is deliberately added to these drinks because of their taste and to cause the addiction to a drink. The caffeine content in soft drinks varies depending on drink type. Energy drinks such as Red Bull are non-alcoholic drinks that contain caffeine and herbal extracts of guarana, ginseng, B vitamins, amino acid derivatives like carnitine and sugar derivatives (ribose, glucuronolactone) (Vuletic *et al.*, 2020).

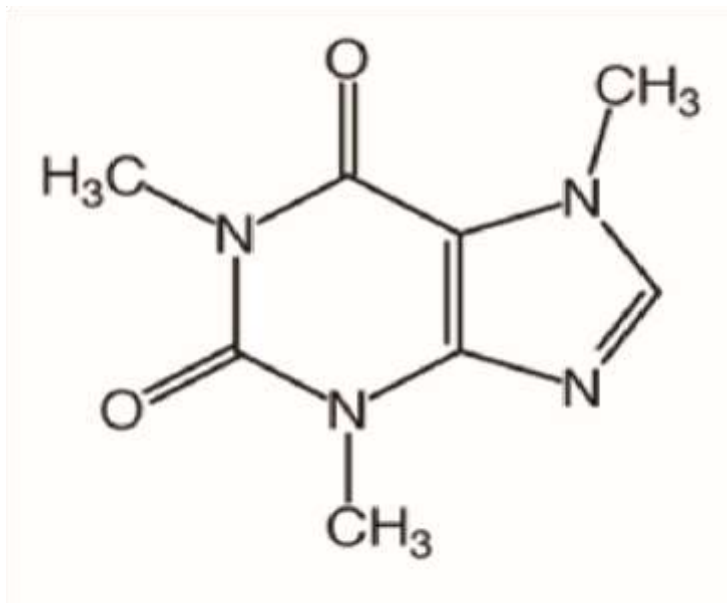


Figure 1: structure of Caffeine (Showkat *et al.*, 2015)

Absorption and Metabolism of Caffeine

Caffeine absorption is nearly complete within 45 minutes after ingestion, with caffeine blood levels peaking after 15 minutes to 2 hours. Caffeine spreads throughout the body and crosses the blood–brain barrier. In the liver, caffeine is metabolized by cytochrome P-450 (CYP) enzymes. Caffeine metabolites include paraxanthine and, in smaller amounts, theophylline and theobromine, which are further metabolized to uric acid and eventually excreted with urine. The half-life of caffeine in adults is typically 2.5 to 4.5 hours but is subject to large variation from one person to another. Smoking greatly accelerates caffeine metabolism, reducing the half-life by up to 50%, whereas oral contraceptive use doubles the half-life of caffeine. Pregnancy greatly reduces caffeine metabolism, especially in the third trimester, when the half-life of caffeine can be up to 15 hours. (Van dam *et al.*, 2020).

Beneficial Effects of Caffeine

The molecular structure of caffeine is similar to that of adenosine, which allows caffeine to bind to adenosine receptors, block adenosine, and inhibit its effects. Accumulation of adenosine in the brain inhibits arousal and increases drowsiness. In moderate doses of 40mg to 300 mg, caffeine can antagonize the effects of adenosine and reduce fatigue, increase alertness, and reduce reaction time (Van dam *et al.*, 2020). Caffeine intake can also improve vigilance during tasks of long

duration that provide limited stimulation, such as working on an assembly line, long-distance driving, and flying aircraft. Although these mental benefits are most pronounced in sleep deprived states. caffeine cannot compensate for the decline in performance after long-term sleep deprivation. Caffeine can contribute to pain relief when added to commonly used analgesic agent (Van dam *et al.*, 2020). Caffeine has been used solely as a chemical marker to track domestic wastewater contamination of both surface water and ground water (Edwards *et al.*, 2013). Low lysophosphatidylcholine (s) with effect on glycerophospholipid metabolism is associated with excessive coffee intake (Alen *et al.*, 2018). Coffee consumption among the adults enhances hearing ability, reduces hearing loss and tinnitus (Lee *et al.*, 2018). Caffeine coffee intake is associated with white matter preservation and cerebral blood flow in Adult (Haller *et al.*, 2018).

Toxic Effects of Caffeine

Side effects of caffeine at very high levels of intake include anxiety, restlessness, nervousness, dysphoria, insomnia, excitement, psychomotor agitation, and rambling flow of thought and speech. Toxic effects are estimated to occur with intakes of 1.2 g or higher, and a dose of 10 to 14 g is thought to be fatal. Caffeine poisoning from consumption of traditional sources of caffeine such as coffee and tea is rare because a very large amount would have to be consumed in a short time for the dose to be fatal. Caffeine-related deaths have generally been due to a very high doses of caffeine from tablets or supplements in powdered or liquid form, mostly in athletes or patients with psychiatric disorders (Van dam *et al.*, 2020). Study revealed excessive consumption of caffeine in coffee causes reasonable alteration in plasma concentration of glucose and high Density Lipoproteins level (Chinedu *et al.*, 2019). Newly pregnant women could risk miscarriage for excessive coffee consumption (Alen, 2018).

Green Tea Leaf (*Camellia Sinensis*)

Camellia sinensis is one of the raw material from which green, white and black tea are produced (kerebih *et al.*, 2020). Tea refers to the agricultural products of the leaves, leaf buds and internodes of plant. The principal constituent of tea, which is responsible for all the properties, is the alkaloid caffeine. Tea is an aromatic beverage commonly prepared by pouring hot or boiling water over cured leaves of the tea plant. Tea likely originated in China as a medicinal drink. It was first introduced to Portuguese priests and merchants in China during the 16th century. Drinking tea became popular in Britain during the 17th century. The

British introduced it to India, in order to compete with the Chinese monopoly on the product (Parvathy *et al.*, 2014). Recent studies suggest that green tea may help reduce the risk of cardiovascular disease and some forms of cancer, promote oral health, reduce blood pressure, help with weight control, improve antibacterial and antiviral activity, provide protection from solar ultraviolet light, and increase bone mineral density. Green tea is also said to have “anti-fibrotic properties, and neuroprotective power (Parvathy *et al.*, 2014). Differences in tea types are consequences of different geographical origin, cultivation conditions and ways of processing. Green tea is one of the most popular tea in Asia and Africa. It is made of unfermented leaves, tastes mild and contains a large amount of caffeine (Vuletic *et al.*, 2017).

Among the plants used in treatment of diseases in Mambila plateau located in Nigerian’s north-eastern region of State Taraba is *Camellia sinensis* from where green tea is made by Mambila beverages Nigeria Limited. *Camellia sinensis* belongs to the family Theaceae (the tea family) with about 450 species and more than 50 genera among angiosperms consisting of trees and shrubs. The leaf is notably used as green tea in Nigeria, and its sale as green tea by this industry has generated huge income to the Taraba State government, Nigeria. The bark decoction is used as remedy for malaria and typhoid fevers by Nguroje people in Mambila plateau (Cletus *et al.*, 2020). The leaf extract had been reported as potential anti-oxidant and potent remedy for cancers in traditional medicine due to the presence of some secondary metabolites such as flavonoids, alkaloids and terpenoids in the leaf extract (Cletus *et al.*, 2020). It is native to the Caribbean, Cuba, Jamaica, Trinidad and Tobago, Dominican Republic, Haiti, Puerto Rico, Barbados; North America: Mexico; Central Africa; Costa-Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Belize; parts of other Africans like Republic of Congo, Ghana, Madagascar, and Nigeria (Cletus *et al.*, 2020). In Nigeria, it is found only in Mambila plateau, Sarduana Local Government of Taraba State, where it grows well in cold climate and temperature range of 5 to 7 °C (Cletus *et al.*, 2020).

Other Brands of Tea

Lipton yellow tea, which is popular among Nigerians is a long age tea manufactured by the Unilever Plc has the lifespan of two years from the time production. It is made from the processed leaves of *Camellia sinensis* plant. Containing polyphenols in abundant is very useful in promoting digestion and

healthy heart, reduces stress, it has smooth mild taste and good flavor (Besa *et al.*,2015).

Top tea is packaged promasidor limited. It contains about 100% black tea, made from the leaves of *Camellia sinensis* supplemented with ginger flavor. Top tea is available in three flavours, which are traditional black tea ginger, ginger tea and lemon tea ginger. Top tea is one of the brand of tea that has under gone more oxidation than other type of tea. It contains an anti-oxidants called theanine which help to reduce stress, anxiety and improves mental performance (Sri Lanka,1993). While hilltop tea comes from the central hills of Sri lanka by the Sri lanka tea growers. It improves mood. It also come in different brands, like black tea. SAM tea also come from formulated Chines herbs (Sri Lanka,1993). The content of caffeine varies in different brands of tea products, depending on the type of tea used in the tea beverage and the proportion of tea in the ingredients. There is need to determine the concentration of caffeine in different beverages products displayed on the market. Therefore, knowing the amount of caffeine in each product will help consumers in the regulation of its intake in tea. The aim of this study is to determine the concentration of caffeine in some commonly consumed tea in Taraba state.

Material and Methods

Equipment used are Uv-Vis Spectrophotometer, Buchner funnel, Filter funnel, separating funnel, measuring cylinders and beakers. All reagents used are of analytical standard. Five brands of commonly consumed tea were bought from different shops. These brands were weighed as follows;

High land tea—8.13gram

Lipton tea -----8.07gram

SAM tea -----6.63gram

Hill top tea-----8.31gram

Top tea -----8.00gram

Extraction of caffeine

Caffeine extraction was done according vuletic *et al.*, (2020). Each tea sample was introduced into a 250ml beaker. Hundred milliliters of distilled water were poured into the 250ml beaker together with the tea sample was boiled. Calcium trioxocarbonate was added to evaporate tannins. The solution was filtered after cooling. The filtrate then was introduced into a separating funnel for liquid to liquid extraction. Two layers of the solution was formed when tetra chloromethane was

introduced into the solution. The caffeine moves into the tetrachloride phase since it is more soluble carbon tetrachloride than water. Solvent phase(CCl₄) is collected by opening the tap of the separating funnel. This procedure of caffeine extraction was repeated three times to obtain appreciable quantity of the caffeine. The collected solvent was subjected to heating to evaporate the solvent and obtain the caffeine formed, which is needle-like shape. Buchner funnel was used with methanol as the solvent to purify the crystals.

Spectrophotometric determination of caffeine

The purified caffeine was weighed. For each of the caffeine obtain from each of the tea brands, 0.2g of each caffeine was dissolved in 80mls of distilled water. It was added up to 100mls to obtain 100mg/ml. two milligram per mil of each solution was introduced into a cuvette and the absorbance was read at 280nm.

Statistical Analysis

Microsoft excel will be used to tabulate the data measured and linear regression will be used to perform.

Result and Discussion

Sample	SAM tea	Hill tea	Top tea	Lipton tea	Top tea	Highland tea
Content of Caffeine (mg/ml)	0.29	0.17		0.34	1.05	0.34

Caffeine concentration present in SAM tea, Hilltop tea, Lipton tea, Top tea and Highland tea were calculated and showed values of 0.29, 0.17, 0.34, 1.05 and 0.34 in mg/ml. from the result above, top tea has the highest caffeine content, followed by Highland tea and Lipton tea. The least is hill top tea. The concentration of caffeine in top tea is the highest as a result, it would be the highest central nervous system stimulant among the other sample tested. This implies it could have a damaging effects among consumers, therefore, consumers' consumption of the beverage is to be minimized.

Lipton tea and Highland tea has the same concentration. Besa *et al* (2015) reported that Lipton yellow tea is produced from the processed leaves of *Camellia sinensis* (green tea) along with highland tea. Having a common source could be the reason for their similarities in their caffeine content. Top tea contains about 100% black tea made from the leaves of *camellia sinensis*, supplemented with ginger (Sri

lanker, 1993). In a research conducted by Vuletic *et al* (2021), indicates black tea contains high content of caffeine. The content of caffeine in tea depends on the condition of the environment during cultivation, growth and types of species (Vuletic *et al.*, 2021). The European Food Safety Authority says “single doses of caffeine that do not raise safety concerns recommended for adults are up to 200mg. the appropriate dose for healthy adult population be 3mg per kilogram of body weight. A single dose of 100mg taken before bed time could affect sleep” (Vuletic *et al.*,2021).

Conclusion

Uv/Vis spectrophotometric method was applied. The advantages for its application include high sensitivity and precision. It is not expensive and easy to perform, small quantity of sample could be analyze. The result gave a preliminary information on the content of caffeine normally consumed in Taraba state. Caffeine content should be indicated on the product label for popularity and accessibility to caffeine containing beverages. Caffeine sometimes can cause ill-health in some individuals, therefore quantities of caffeine need to be shown on the label for the interest of those consuming them.

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